

## ҒЫЛЫМ ЖАРШЫСЫ АТЫНДАҒЫ ҚАЗАҚ АГРОТЕХНИКАЛЫҚ ЗЕРТТЕУ УНИВЕРСИТЕТІНІҢ ҒЫЛЫМ ЖАРШЫСЫ

Сәкен Сейфуллин атындағы Қазақ агротехникалық зерттеу университетінің Ғылым жаршысы (пәнаралық) =Вестник науки Казахского агротехнического исследовательского университета имени Сакена Сейфуллина (междисциплинарный). – 2023. -№ 2 (117). - P.4-11.

doi.org/ 10.51452/kazatu.2023.2(117).1368

UDC 665.117.2

### STUDY OF THE SAFETY INDICATORS OF OILSEED CAKES

*Satayeva Zhuldyz Isakovna*

*PhD*

*RSE "Kazakhstan Institute of Standardization and Metrology"*

*Astana, Kazakhstan*

*E-mail: julduz.kaynar@mail.ru*

*Mukhambetov Gabit Mukhambetovich*

*Doctor of Economic Sciences*

*RSE "Kazakhstan Institute of Standardization and Metrology"*

*Astana, Kazakhstan*

*E-mail: ceo@ksm.kz*

*Mashanova Nurbibi Sovetovna*

*Doctor of Technical Sciences*

*RSE "Kazakhstan Institute of Standardization and Metrology"*

*Astana, Kazakhstan*

*E-mail: nurmashanova@gmail.com*

*Smagulova Mirgul Esengaliyevna*

*Candidate of Chemical Science*

*RSE "Kazakhstan Institute of Standardization and Metrology"*

*Astana, Kazakhstan*

*E-mail: mirgul.smagulova@bk.ru*

---

#### Abstract

The purpose of this research is the use of secondary raw materials of oil and fat industry enterprises, oilseed cake, for the development of new enriched food products with increased biological and nutritional value. The objects of research were flaxseed, soybean, peanut, and pumpkin oilcake obtained based on an experimental production workshop for the processing of oilseeds. This article presents the results of organoleptic, physico-chemical, and microbiological indicators, the content of toxic elements, the content of heavy metals, and the energy value of the studied cakes for further use in the development of bakery, confectionery, and pasta products was determined. All indicators do not exceed the requirements established by regulatory documents. According to the results of the research, high content of proteins from 29.6 in peanut and up to 37.5 in pumpkin oilcake was revealed; toxicity in rabbits was not detected, cadmium, mycotoxins, Bacteria of the Escherichia coli group BECG (coliforms), yeasts, molds were not detected; other toxic elements, the number of mesophilic aerobic and facultative anaerobic microorganisms (NMAFAM), heavy metals do not exceed the allowable limits. Domestic oilseed processing by-products can enable the reuse of materials in the supply chain as they add value to food, reduce costs, promote economic growth, and reduce the risks associated with their disposal in the environment.

**Key words:** oilseeds; oilcake; protein; food safety; quality indicators; energy value.

### Basic position and Introduction

The remains of the oil and fat industry can be used as by-products for high-value-added products and food additives. When proteins and carbohydrates dominate the cake, they can be used as filler in dairy and meat production. Bochkarev [1] found the use of flax cake rich in proteins and fiber in bakery and confectionery products.

According to Teh [2] and Zając [3], oilseed cake and subsequently oilseed meal are valuable sources of gluten-free proteins, which are a suitable alternative to replace animal or other vegetable protein sources, as they are easily digestible, non-toxic and quite nutritious.

A group of scientists led by Bochkarev [1] found that the composition of cake/meal depends on the variety, pressing method and growing conditions. The taste and smell are characteristic of the feedstock without mustiness, mold, rancidity and foreign odors. The color of pumpkin seed cake is brown to brownish-green with a tasteless and sweetish aftertaste. Flax seed cake has various shades of brown with a neutral and bland taste.

### Materials and methods

Samples of the studied oilcake samples were obtained based on the experimental production workshop for the production of vegetable oils of the S.Seifullin Kazakh Agrotechnical University. Vegetable oils are used for food purposes and new product development [8]. Flax, soybean, peanut, and pumpkin seeds of the 2022 harvest were dried and pressed on a screw oil press. After pressing, the main product is obtained - flaxseed, soybean, peanut, and pumpkin raw oil. The oilcake is a secondary product of oilseed processing, which

The remains of the oil and fat industry can be used as by-products for high value-added products and food additives. During four months of storage, Tarek-Tilistyák et al. [4] observed that the activity of the water remained stable, inhibiting the growth of bacteria and mold. Macronutrients decrease after a month, and the lowest levels of contamination were found in walnuts and the highest in flaxseed.

The use of protein- and fiber-rich cakes (flax) by Sunil et al. [5] was found in bakery and confectionery products.

A group of scientists led by Gültekin Subaşı [6] used solid cake from sesame and coconut to prepare four healthy products. According to Ançuța [7], due to its nutritional properties, sunflower cake is a good source of good functional foods that also have good sensory characteristics.

Purpose of this article - researching to assess the organoleptic, physico-chemical indicators and safety indicators of oilcake from flax seeds, soybeans, peanuts, and pumpkin.

until now has been mainly used as animal feed. Few studies are devoted to studies on the use of oilcake as a dietary supplement.

Research of the organoleptic quality indicators of the obtained cake from flax seeds, soybeans, peanuts and pumpkins were carried out in October-November 2022.

Samples of the studied oilcake samples are shown in fig. 1: sample No. 1 - flaxseed oilcake; sample No. 2 - soybean oilcake; sample No. 3 - peanut oilcake; sample No. 4 - pumpkin oilcake.

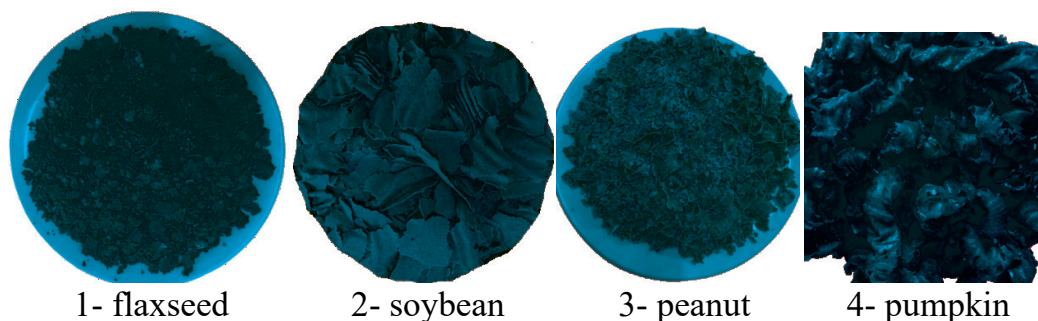


Figure 1 – Appearance of the samples of the studied cakes

The objects of the study were: cake obtained after a single pressing of flax, soybean, peanut and pumpkin seeds.

Organoleptic, physicochemical, microbiological indicators of the quality of cake samples, the

content of toxic elements and heavy metals in them were carried out in accordance with regulatory documents.

The physicochemical composition of cakes was determined by the express method on the

device NIRS DA1650, Foss Analytical, Denmark;

Before the study, all types of cakes were crushed in a laboratory crusher and sieved through a sieve with a mesh opening diameter of 0.4 mm.

To determine the microbiological and safety indicators of cakes, the samples were transferred to the Republican State Veterinary PVC Laboratory.

## Results

The characteristics of the organoleptic and physical indicators of oilcakes are given in table 1.

Table 1 - Organoleptic indicators of the quality of the samples of oilcakes

| The name of indicators                                | Name of oilcakes  |               |                     |                                  |
|---|---|---------------|---------------------|----------------------------------|
|   | Flaxseed  | Soybean       | Pumpkin             | Peanut                           |
| 1   | 2   | 3             | 4                   | 5                                |
| Appearance and  | Free of foreign inclusions and impurities   |               |                     |                                  |
| Color   | Dark brown powder   | Yellow powder | Yellow-green powder | Light brown powder with red dots |
| Smell   | Peculiar to the corresponding type of oilseed raw material without foreign smell (mustiness, mold, burning, etc.) |               |                     |                                  |
| Taste   | Peculiar to the corresponding type of oilseed raw materials, without rancidity and other foreign flavors          |               |                     |                                  |
| Metal-magnetic impurity, mg per 1 kg of cake, no more | Is absent   |               |                     |                                  |
| Consistency   | Loose, homogeneous  |               |                     |                                  |
| Other foreign matter                                  | Is absent   |               |                     |                                  |
| Pest infestation or evidence of infestation           | Is absent   |               |                     |                                  |

Table 2 - Physical and chemical parameters of oilcakes

| The name of indicators  | Name of oilcakes |         |        |         |
|---|------------------|---------|--------|---------|
|   | Flaxseed         | Soybean | Peanut | Pumpkin |
| Physical and chemical indicators:<br>- moisture content, %;                             | 6,5              | 7,9     | 8,0    | 7,8     |
| - mass fraction of protein, %;  | 34,4             | 32,6    | 29,6   | 37,5    |
| - mass fraction of fat, %   | 25,4             | 18,8    | 25,6   | 25,5    |
| Mass fraction of ash insoluble in hydrochloric acid, in terms of dry matter, %, no more | 0,67             | 0,35    | 0,13   | 0,44    |
| Indicators of oxidative deterioration of fat  |                  |         |        |         |
| - acid number, mg KOH/g fat, not more than  | 1,8              | 1,3     | 1,5    | 1,7     |
| - peroxide value, mole of active oxygen/kg of fat, not more than                        | 4,2              | 3,9     | 3,9    | 3,5     |

The highest protein content was found in pumpkin oilcake - 37.5%, then in linseed oilcake - 34.4%, in soybean oilcake - 32.6%, and in peanut oilcake, it was 29.6%. The results are comparable to sunflower cake, flax, cold-pressed pumpkin containing 19.9-44.9; 14.4-41.9; 29.4-53.9% of crude protein, respectively, which were carried out by Ancuta and Sonia [9].

Abdullah [10] argues that moisture content is an important factor in maintaining cake stability over a long period of time. According to Popović [11], levels below 12% are considered safe for storage, as they prevent rapid mold growth. The values obtained by Sinkovič and Sunil [12, 13] were 6.5% for flaxseed meal, 7.9% for soybean meal, 8.0% for peanut meal and 7.8% for pumpkin

meal. Values were relatively similar to those for soybean, rapeseed, sesame and flaxseed.

Significantly lower values were found for hemp and pumpkin seeds.

**Discussion**

The results of the fat content analysis were as follows: 25.4% for flaxseed oilcake, 18.8% - for soybean, 25.6% for peanut, and 25.5% for pumpkin oilcake. The mass fraction of fat in the studied fats was high since these cakes were obtained after a single cold pressing. But the by-products of cold-pressed oils are characterized by high nutritional value and good functional performance. The oilcake can be used as a food ingredient or to extract biologically active compounds that can be included in new foods because they are nutritious, social, and cost-effective.

According to the content of insoluble ash (0.13–0.67%), all types and batches of cake meet

the requirements of the current RD.

Indicators of oxidative deterioration acid number (1.3-1.8) and peroxide number (3.5-4.2), calculated considering the oil content, are within the safety levels established for oil and fat products. The nutritional value of the studied samples of cakes is presented below.

For the further use of cake for the development of food products, the content of toxic elements, especially cadmium and lead, in the cake of flax seeds, soybeans, pumpkin, and peanuts, are also of interest. The results of the analysis are presented in table 3.

Table 3 - The content of toxic elements in cake

| The name of indicators | Name of oilcakes |              |              |              |
|------------------------|------------------|--------------|--------------|--------------|
|                        | Flaxseed         | Soybean      | Peanut       | Pumpkin      |
| Toxicity in rabbits    | Non toxic        |              |              |              |
| Toxic elements:        |                  |              |              |              |
| - cadmium, mg/kg;      | Not detected     | Not detected | Not detected | Not detected |
| - lead, mg/kg;         | 0,057±0,017      | 0,054±0,016  | 0,028±0,008  | 0,059±0,017  |
| - arsenic, mg/kg.      | 0,058±0,020      | 0,027±0,009  | 0,0320,011   | 0,032±0,011  |

As can be seen from Table 3, the studied samples of cake are not toxic, cadmium is not detected, and the content of lead and arsenic in oilseed cake does not exceed permissible levels.

The most common microbiological test is an indicator of the number of mesophilic aerobic and facultative anaerobic microorganisms (total bacterial contamination). It is widely used in food

technology for microbiological assessment of the quality of raw materials or products.

From a safety point of view, identification and quantification of molds and yeasts are necessary since their increased content compared to the permissible content can cause microbial diseases such as mycotoxicoses.

Table 4 - Microbiological indicators of cakes

| The name of indicators                                       | Name of oilcakes               |         |        |         |
|--|--------------------------------|---------|--------|---------|
|  | Flaxseed                       | Soybean | Peanut | Pumpkin |
| 1  | 2                              | 3       | 4      | 5       |
| Mycotoxins:  |                                |         |        |         |
| - zearalenone (F-2), mg/kg                                   | Not detected                   |         |        |         |
| - T-2 toxin, mg/kg   | Not detected                   |         |        |         |
| - deoxyvalennol  | Not detected                   |         |        |         |
| 1  | 2                              | 3       | 4      | 5       |
| Microbiological indicators:                                  |                                |         |        |         |
| - BECG (coliforms) in 0.1 cm <sup>3</sup> (g) of the product | Not detected                   |         |        |         |
| - NMAFAM, CFU/g, no more                                     | Up to 200 thousand m.c. in 1 g |         |        |         |
| - Yeast CFU/g, no more                                       | Not detected                   |         |        |         |
| - Molds, CFU/g, no more                                      | Not detected                   |         |        |         |

It was established that mycotoxins zearalenone (F-2), T-2 toxin, deoxyvalenol, BECGKP (coliforms), yeasts, and molds were not detected. The mass fraction of NMAFAM did not exceed the MAC norms up to 200 thousand m.c. in 1 g at an acceptable rate according to GOST 25311-82, no more than 500 thousand m.k. in 1 g.

Heavy metals may be present in raw materials

grown on contaminated soils. They can get from the atmosphere as part of gaseous emissions, fumes, and technogenic dust; in the form of industrial waste, sewage, household waste, and mineral fertilizers. Therefore, it is necessary to analyze the presence of heavy metals in food. Table 5 shows the results of the analysis of the content of radionuclides.

Table 5 - The content of heavy metals in cake

| The name of indicators | Name of oilcakes |             |             |            |
|------------------------|------------------|-------------|-------------|------------|
|                        | Flaxseed         | Soybean     | Peanut      | Pumpkin    |
| Radionuclides:         |                  |             |             |            |
| - Cesium-137, Bq/kg    | 0,00±26,80       | 14,90±26,80 | 11,80±19,90 | 0,00±25,90 |
| - Strontium-90, Bq/kg  | 0,00±14,90       | 9,20±15,00  | 4,80±11,40  | 7,30±14,70 |

These table confirm that the mass fraction of heavy metals in the composition of cakes is in the minimum amount and does not exceed the MPC norms for cesium-137 - no more than 180 Bq/kg, for strontium-90 - no more than 100 Bq/kg. Cesium-137 was not found in linseed and pumpkin pomace.

Table 6 - Nutritional value and calorie content of oilseed cakes

| The name of oilcakes | Content, % |      |               | Calorie content, kcal |
|----------------------|------------|------|---------------|-----------------------|
|                      | Protein    | Fat  | Carbohydrates |                       |
| Flaxseed             | 34,4       | 25,4 | 12            | 464,2                 |
| Soybean              | 32,6       | 18,8 | 35,9          | 443,2                 |
| Peanut               | 29,6       | 25,6 | 18            | 420,8                 |
| Pumpkin              | 37,5       | 25,5 | 23            | 471,5                 |

The calorie content of all samples is approximately the same, from 420.8 kcal for peanut cake and up to 471.5 kcal for pumpkin cake. The high caloric content is explained by the high-fat content in oilcake, as they are obtained after a single cold pressing, which has better nutritional properties than oilseed cakes obtained after degreasing with organic solvents.

### Conclusions

According to the results of the research, it follows that all the studied cakes meet the established requirements for the above cakes in terms of organoleptic and physical quality indicators and are safe for their further use in the production of food products, namely for the production of bakery, confectionery and pasta products, provided for in further research.

The nutritional value of oilseed cake is represented by a high protein content in the range of 29.6-37.5%, low levels of oxidative spoilage, an acid number from 1.3 to 1.8 mg KOH per g of fat, a peroxide value of 3.5-4.2 mol of active oxygen per kg of fat, low moisture content of 6.5 to 8%.

For safety indicators, the results of the analyzes confirmed that the cake of flax, soybean, peanut and pumpkin seeds is not toxic, mycotoxins, yeasts and molds were not detected, and other indicators do not exceed the allowable limits of regulatory documents.

Thus, improving the nutritional value of domestic oilseed by-products can enable the reuse of materials in the supply chain, namely in the production of flour products, as they add value to food, reduce costs, promote economic growth, and reduce the risks associated with their disposal in the environment.

### Information on financing

The article was written within the framework of the scientific and technical program of program-targeted financing of the Republic of Kazakhstan: IRNBR12967830 "Development of technical regulation tools to improve the efficiency, safety, resource-saving of food production and environmentally friendly

packaging." The authors thank the RSE "Kazakhstan Institute of Standardization and Metrology" of the Committee for Technical Regulation and Metrology of the Ministry of Trade and Integration of the Republic of Kazakhstan for their support. There is no conflict of interest.

### References

- 1 Bochkarev M.S.; Egorova E.Y.; Reznichenko I.Y.; Poznyakovskiy V.M. Reasons for the ways of using oilcakes in food industry [Text] / *Foods Raw Mater.* -2016. -№ 4. -P.4–12. [Google Scholar].
- 2 Teh S.S., Bekhit A.E. Utilization of oilseed cakes for human nutrition and health benefits. In: Hakeem K.R., Jawaid M., Alothman O.Y., editors [Text]/ *Agricultural Biomass Based Potential Materials.* Springer International Publishing; Cham, Switzerland: -2015. -P. 191-229.
- 3 Zając M., The quality of pork loaves with the addition of hemp seeds, de-hulled hemp seeds, hemp protein and hemp flour [Text]/ Guzik P., Kulawik P., Tkaczewska J., Florkiewicz A., Migdal W. // *LWT-Food Sci. Technol.* -2019. -№ 105. -P.190-199. doi: 10.1016/j.lwt.2019.02.013.
- 4 Tarek-Tilistyák J.; Juhász-Román M.; Jeko J.; Mathe E. Short-term storability of oil seed and walnut cake-Microbiological aspect [Text]/ *Acta Aliment.* -2014. -№ 43. -P. 632–639. [Google Scholar].
- 5 Sunil L.; Development of Health Foods from Oilseed Cakes. J. [Text]/ Prakruthi A.; Prasanth Kumar P.K.; Gopala Krishna A.G. // *Food Process. Technol.* -2016. -№7. -P.1-6. [Google Scholar].
- 6 GültekinSubaşı B.; Vahapoğlu B.; Capanoglu E.; Mohammadifar M.A. A review on protein extracts from sunflower cake: Techno-functional properties and promising modification methods [Text]/ *Crit. Rev. Food Sci. Nutr.* -2021. -№1-16. [Google Scholar].
- 7 Ancuța P., Sonia A. Oil press-cakes and meals valorization through circular economy approaches [Text]/ *Appl. Sci.* -2020. -№10. -P.7432. doi: 10.3390/app10217432.
- 8 Satayeva Zh.I. Organic product with balanced composition OF  $\omega$ -6 and  $\omega$ -3 fatty acids [Text] *Bulletin of Science of KazATU named after S. Seifullin*, -2020. -№3(106). -P.253-260.
- 9 Rani R.; Badwaik L.S. Functional Properties of Oilseed Cakes and Defatted Meals of Mustard, Soybean and Flaxseed [Text]/ *Waste Biomass Valorization*, -2021. -№ 12. -P. 5639–5647. [Google Scholar] [CrossRef].
- 10 Abdullah M.H.R.O., Ch'ng P.E., Lim T.H. Some Physical Properties of Parkia Speciosa Seeds [Text]/ *Int. Conf. Food Eng. Biotechnol.* -2011.-№ 9. -P.43–47. [Google Scholar].
- 11 Popović S.; Valorization of By-Products from the Production of Pressed Edible Oils to Produce Biopolymer Films [Text]/ Hromiš, N.; Šuput, D.; Bulut, S.; Romanić, R.; Lazić, V. // *In Cold Pressed Oils*; Academic Press: Cambridge, MA, USA, - 2020. -P. 15–30. [Google Scholar] [CrossRef].
- 12 Sinkovič L.; Kolmanič, A. Elemental composition and nutritional characteristics of cucurbita pepo subsp. Pepo seeds, oil cake and pumpkin oil [Text] /*J. Elem.* -2021. -№26. -P. 97–107. [Google Scholar] [CrossRef].
- 13 Sunil L.; Preparation of food supplements from oilseed cakes [Text]/ Appaiah P.; Prasanth Kumar P.K.; Gopala Krishna A.G. // *J. Food Sci. Technol.* 2015, 52, 2998–3005. [Google Scholar] [CrossRef] [Green Version].

## КҮНЖАРАЛАРДЫҢ ҚАУІПСІЗДІК КӨРСЕТКІШТЕРІН ЗЕРТТЕУ

*Сатаева Жұлдыз Исаковна*

*PhD*

*«Қазақстан стандарттау және метрология институты» РМК*

*Астана қ., Қазақстан*

*E-mail: julduz.kaynar@mail.ru*

*Мухамбетов Габит Мухамбетович*

*Экономика ғылымдарының докторы*

*«Қазақстан стандарттау және метрология институты» РМК*

*Астана қ., Қазақстан*

*E-mail: ceo@ksm.kz*

*Машианова Нурбиби Советовна*

*Техника ғылымдарының докторы*

*«Қазақстан стандарттау және метрология институты» РМК*

*Астана қ., Қазақстан*

*E-mail: nurmashanova@gmail.com*

*Смагулова Миргуль Есенгалиевна*

*Химия ғылымдарының кандидаты*

*«Қазақстан стандарттау және метрология институты» РМК*

*Астана қ., Қазақстан*

*E-mail: mirgul.smagulova@bk.ru*

### **Түйін**

Бұл зерттеудің мақсаты биологиялық және тағамдық құндылығы жоғары жаңа байытылған тамақ өнімдерін өндіру үшін май өнеркәсібі кәсіпорындарының қайталама шикізатын, майлы дақылдарды пайдалану болып табылады. Зерттеу нысандары майлы дақылдарды өңдеу бойынша тәжірибелік-өндірістік цех негізінде алынған зығыр, соя, жержаңғақ және асқабақ күнжаралары болды. Бұл мақалада наубайхана, кондитерлік және макарон өнімдерді дамытуда пайдалану үшін күнжаралардың органолептикалық, физика-химиялық, микробиологиялық көрсеткіштері, сонымен қатар улы элементтердің құрамы, ауыр металдар мөлшері және энергетикалық құндылығы анықталды. Барлық көрсеткіштер нормативтік құжаттарда белгіленген талаптардан аспайды. Зерттеу нәтижелері бойынша жержаңғақта 29,6-дан және асқабақ күнжарасында 37,5-ке дейін ақуыздың жоғары мөлшері анықталды; қояндарда уыттылық анықталмады, кадмий, микотоксиндер, Escherichia таяқшасы тобындағы бактериялар (колиформдар), ашытқылар, зендер анықталмады; басқа улы элементтер, мезофильді аэробты және факультативті анаэробты микроорганизмдердің саны, ауыр металдар рұқсат етілген шектен аспайды. Майлы дақылдарды өңдеудің отандық жанама өнімдері жеткізу тізбегіндегі материалдарды қайта пайдалануды қамтамасыз ете алады, өйткені олар азық-түлікке құндылық қосады, шығындарды азайтады, экономикалық өсуге ықпал етеді және оларды қоршаған ортаға тастаумен байланысты тәуекелдерді азайтады.

**Кілт сөздер:** майлы дақылдар; күнжара; ақуыз; азық-түлік қауіпсіздігі; сапа көрсеткіштері; энергетикалық құндылық.

## ИССЛЕДОВАНИЕ ПОКАЗАТЕЛЕЙ БЕЗОПАСНОСТИ МАСЛИЧНЫХ ЖМЫХОВ

*Сатаева Жулдыз Исаковна*

*PhD*

*РГП «Казахстанский институт стандартизации и метрологии»*

*Астана, Казахстан*

*E-mail: julduz.kaynar@mail.ru*

*Мухамбетов Габит Мухамбетович*

*Доктор экономических наук*

*РГП «Казахстанский институт стандартизации и метрологии»*

*Астана, Казахстан*

*E-mail: ceo@ksm.kz*

*Машианова Нурбиби Советовна*

*Доктор технических наук*

*РГП «Казахстанский институт стандартизации и метрологии»*

*Астана, Казахстан*

*E-mail: nurmashanova@gmail.com*

*Смагулова Миргуль Есенгалиевна*

*Кандидат химических наук*

*РГП «Казахстанский институт стандартизации и метрологии»*

*Астана, Казахстан*

*E-mail: mirgul.smagulova@bk.ru*

### **Аннотация**

Целью данного исследования является использование вторичных сырьевых ресурсов предприятий масложировой промышленности, жмыхов масличных культур, для разработки новых обогащенных продуктов питания с повышенной биологической и пищевой ценностью. Объектами исследований были льняной, соевый, арахисовый и тыквенный жмыхи, полученные на базе экспериментально-производственного цеха по переработке масличных культур. В данной статье приводятся результаты исследований органолептических, физико-химических, микробиологически показателей, а также содержание токсичных элементов, содержание тяжелых металлов и энергетическая ценность исследуемых жмыхов для дальнейшего использования в разработке хлебобулочных, кондитерских и макаронных изделий. Все показатели не превышают требования, установленные нормативными документами. По результатам исследований выявлено высокое содержание протеинов от 29,6 в арахисовом и до 37,5 в тыквенном жмыхе; токсичность на кроликах не обнаружена, кадмий, микотоксины, БГПК (колиформы), дрожжи, плесени не обнаружены; другие токсичные элементы, КМАФАнМ, тяжелые металлы не превышают допустимые нормы. Отечественные побочные продукты переработки маслосемян могут обеспечить повторное использование материалов в цепочке поставок, поскольку они повышают ценность продуктов питания, снижают затраты, способствуют экономическому росту и снижают риски, связанные с их утилизацией в окружающей среде.

**Ключевые слова:** масличные семена; жмых; белок; пищевая безопасность; качественные показатели; энергетическая ценность.